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UPPER WINDS AT WADI HALFA (SUDAN)

By J. DURWARD, M.A.

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UPPER WINDS AT WADI HALFA (SUDAN)

By J. DURWARD, M.A.

In July, 1934, a station for the measurement of upper winds was established at Wadi Halfa on the northern border of the Anglo-Egyptian Sudan. In view of the importance of this station which is the only upper wind station between Cairo and Khartoum—a distance of about 1,120 miles—it was considered desirable to summarise the results as soon as 12 months' observations were completed. The period of twelve months is, as a rule, too short to enable one to draw reliable conclusions but the case of Wadi Halfa is probably unique: the pressure distribution there undergoes so little change from month to month or from summer to winter that a set of observations for a complete year is probably adequate for obtaining a good idea of normal upper wind conditions at this station.

Wadi Halfa lies between two distinct pressure systems. To the north is the high pressure which is maintained over the desert west of Egypt, throughout the year. Halfa is sufficiently distant from the coast to escape practically the whole effect of those depressions which pass along the Mediterranean in winter and which cause winds to blow from the south in Egypt. Thus southerly winds are rare at Wadi Halfa in winter. Certain exceptional cases are discussed at the end of this note. To the south of Halfa is the Sudan pressure system which undergoes a marked development in the course of the year. The winter equatorial low pressure moves in a northerly direction in the spring until its centre reaches about latitude 15° N. in May when it turns to the north-east and advances across Arabia. South of latitude 18° N., southerly winds are caused in summer by this depression. But its centre when it turns to the north-east is still about 400 miles south of Halfa so that the winds at this station, with few exceptions, blow from the north throughout the summer. Accordingly the wind at Halfa rarely blows from any quarter other than the north throughout the year.

The upper wind observations at Wadi Halfa (21° 55′ N., 31° 19′ E., height 420 ft.) are taken from the Nile Hotel of the Sudan Government Railways. This hotel, whose gardens run along the river's eastern bank faces due north and south and from the western end of its flat roof about 50 feet off the ground a clear view of the sky can be obtained unrestricted by palm trees or other obstacles. The theodolite is set on a survey mark on the top of a small Jebel about one mile across the Nile—the bearing of this mark being 254°. The view east and west at Wadi Halfa is limited to 2 or 3 miles by the ranges of small basalt hills which flank the Nile valley. North and south, however, the country is more open, particularly to the south where on a clear day one can see past the second cataract to a distance of 15–20 miles.

Observations are made nearly every day at about 0700 local time (2 hours ahead of G.M.T.). The wind is given at heights

above M.S.L.—i.e. the wind at 1,500 ft. is the wind at 1,500 ft. above M.S.L. or 1,000 ft., approximately, above ground level.

Results.—The results of the observations for surface, 1,500, 3,000, 6,000 and 10,000 ft. for each month are given in the form as recommended by the International Commission for Air Navigation (Tables 1–6). This is a convenient form of presenting data when it is desired to construct wind roses, either of the ordinary type or of Shaw-Garbett type (1),* when the data for twelve months for each of eight cardinal points are represented on the sides of an octagon.

It is considered, however, that the method adopted by Sutton (2), and by Brooks (3), is a much more graphic way of presenting the results from a station like Wadi Halfa, where the outstanding feature is constancy of wind direction. Briefly, the method consists in combining the various directions at each height into direction-frequency vectors, which are compiled by assigning unit value to each observation of wind direction, irrespective of force. The direction of the resultant of these at any particular altitude gives the mean wind direction at that altitude while its magnitude, expressed as a percentage of the number of observations, gives the constancy. Thus if the wind were to blow every day from the same direction the constancy would be 100 per cent. This method does not give the actual resultant air flow but for aviation purposes resultant air flow is not of much practical importance: the numerical value of the direction frequency vector gives a better idea of the steadiness of the wind from one direction than it would if account were taken of velocity.

Discussion.—The diagrams (Plates I–VI) show that there are three well-marked types of wind variation with height at Wadi Halfa.

Winter type.—A wind of 360°–40° below 5,000–6,000 ft. backing to about 300° at 10,000 ft. and continuing without much change to 13,000 ft. This type of variation is exemplified in the diagrams for the winter months December to February. The velocity is a maximum at 2,000 ft. and both velocity and constancy are at their minimum 5,000–6,000 ft. For north-bound aircraft wishing to avoid the strong head wind at low levels, this height, on the average, would prove the most economical.

Transitional Period (a).—The second type of variation is exemplified by the diagrams for March, April, May and June. During these months, the wind is from 360°–50° at low levels but there is no marked change at 5,000–6,000 ft.—the change takes place much more slowly than in winter and the wind does not on the average back beyond 360°. In June the "constancy" above 9,000 ft. is very small and the resultant direction irregular—obviously a change towards the summer type. The change of speed

* The numbers in brackets refer to the bibliography on p. 5.

with height is much the same as in winter, namely a maximum at 2,000 ft. followed by a gradual decrease with a minimum between 7,000 and 9,000 ft. In March and April the " constancy " at these heights is so great that there is little to be gained by flying very high on a north-bound flight but in May and June, when the constancy is very much less, the chance of getting a favourable wind is much greater at say 10,000 ft. than at 5,000 ft.

Summer Period.—The next type is the summer type, as exemplified in the diagrams for July, August and September. During these months the wind backs from about 20° at low levels to between 230° and 260° at 10,000 ft. The constancy, especially during July and August, is very high at all levels. The most favourable height for north-bound aircraft in this case is thus 10,000 ft. or above. As in the other two cases the wind speed is a maximum at 2,000 ft. and a minimum between 6,000 and 8,000 ft.

Transitional Period (*b*).—The variation in the two remaining months, October and November, resembles that in the period March–June. This is to be expected, as both are transitional periods between summer and winter. In November the wind on the average does not back beyond 360°. October is the only month in which the average wind veers with height and at 10,000 ft. the resultant direction is actually 155°. The speed is, as usual, a maximum at 2,000 ft. and a minimum about 6,000 ft. It should be noted that the lowest average speeds at 6,000 and 10,000 ft. are experienced during this transitional period.

The annual variation of average wind speed at the four heights recommended in the International Commission for Air Navigation summaries, 1,500, 3,000, 6,000 and 10,000 ft. is as follows :—

Ft.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Range
1,500 ..	19	21	19	20	16	17	*15*	*15*	23	19	16	17	8
3,000 ..	18	22	22	26	19	19	19	*18*	27	21	18	19	9
6,000 ..	15	17	17	23	16	16	17	12	12	12	*10*	15	13
10,000 ..	22	18	22	21	13	14	16	12	16	*9*	13	14	13

The lowest velocities at all heights occur during the second half of the summer period or during transitional period (*b*), whilst the highest velocities occur in April. September at 1,500 and 3,000 ft. is an exception, but the results 23 and 27 m.p.h. are confirmed by the corresponding month of 1935, the mean speeds being 22 and 27 m.p.h. respectively.

Certain special cases.—On about 17 occasions during the twelve months the 2,000 ft. wind at Wadi Halfa was SE. to S. These occasions are briefly discussed in the table below :—

Date	Remarks
1934.	
August 14 ..	Sudan depression further north than usual—sand haze at Wadi Halfa on both days.
„ 15 ..	
October 23 ..	Depression near Dakhla oasis.

Date	Remarks
1935.	
January 27 ..	Depressions over Greece and western desert giving a south-easterly gradient from Atbara to north Russia.
,, 28 ..	Depressions eastern Mediterranean and near Dakhla.
,, 29 ..	Depressions eastern Mediterranean and near Dakhla.
February 12 ..	Depression over Greece with trough extending over western desert.
,, 13 ..	Pressure distribution as on February 12. *Duststorm* at Wadi Halfa at shift of wind from SE. to NW.
March 18 .	Pressure distribution similar to January 27. *Duststorm* on March 19 at change of wind.
,, 29 ..	Pressure distribution similar to January 27 or March 18. *Duststorm* on March 30.
April 30 ..	Pressure distribution similar to March 18. *Duststorm* on change of wind.
May 1 ..	
,, 2 ..	
,, 3 ..	
,, 5 ..	Depression near Wadi Halfa probably formed between the cool north-easterly current which had arrived 2 days before and a relatively warm south-easterly current from the Red Sea.
,, 6 .	
,, 26 ..	Sudan low further north than usual.

It will be noted that the majority of south-easterly winds are due to a depression in the western desert, which is generally associated with a depression further north (over the Mediterranean or Europe). When this is the case, the shift of wind from warm SE. to cold NW. or N. is nearly always accompanied by sandstorms.

In other cases the south-easterly winds are caused by an extension northwards of the Sudan low or by shallow depressions which form in the desert during the transitional periods May and October. Sand haze may be associated with such depressions but not severe sandstorms because the winds are too light and the depressions so limited in extent that their passage eastwards is not accompanied by any marked influx of cold air such as occurs with Mediterranean depressions.

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Speed	AUGUST, 1934. N.	NE.	E.	SE.	S.	SW.	W.	NW.	SEPTEMBER, 1934. N.	NE.	E.	SE.	S.	SW.	W.	NW.
Surface 0–3 m.p.h. 0. Total cases, 22. / 24.																
m.p.h.																
4–15 ..	15	2	2	..	..	..	..	2	11	2	..	..	..	..	..	..
16–31 ..	..	..	..	1	..	..	..	..	9	2	..	..	..	..	..	..
32–47 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
48 and over..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	9·7	11·0	4·5	23·0	..	..	..	4·0	15·2	13·5	..	..	..	..	..	..
Total ..	15	2	2	1	..	..	..	2	20	4	..	..	..	..	..	..
1,500 feet 0–3 m.p.h. 0. Total cases, 22. / 24.																
m.p.h.																
4–15 ..	5	2	1	1	..	..	..	1	..	2	..	..	..	..	..	..
16–31 ..	9	2	..	1	..	..	..	..	19	3	..	..	..	..	..	..
32–47 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
48 and over..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	15·8	13·5	9·0	15·5	..	..	..	9·0	24·0	19·0	..	..	..	..	..	..
Total ..	14	4	1	2	..	..	..	1	19	5	..	..	..	..	..	..
3,000 feet 0–3 m.p.h. 0. Total cases, 21. / 24.																
m.p.h.																
4–15 ..	4	3	..	..	1	..	..	1	..	..	..	..	..	..	..	..
16–31 ..	11	..	..	..	..	..	..	..	17	3	..	..	..	..	..	..
32–47 ..	1	..	..	..	..	..	..	..	3	1	..	..	..	..	..	..
48 and over..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	20·1	12·3	..	..	7·0	..	..	5·0	26·9	24·0	..	..	..	..	..	..
Total ..	16	3	..	..	1	..	..	1	20	4	..	..	..	..	..	..
6,000 feet 0–3 m.p.h. 0. Total cases, 21. / 2. Total cases, 21.																
m.p.h.																
4–15 ..	4	..	1	..	..	4	3	5	3	1	..	..	..	3	4	1
16–31 ..	..	..	..	..	..	..	1	3	5	..	..	..	..	..	..	2
32–47 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
48 and over..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	14·3	..	6·0	..	..	13·0	12·3	12·1	17·3	12·0	..	..	..	6·0	12·2	16·3
Total ..	4	..	1	..	..	4	4	8	8	1	..	..	..	3	4	3
10,000 feet 0–3 m.p.h. 0. Total cases, 14. / 14.																
m.p.h.																
4–15 ..	..	..	..	..	1	5	7	..	..	3	..	..	2	1	1	1
16–31 ..	..	..	..	..	..	1	..	..	..	..	..	..	..	5	1	..
32–47 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
48 and over..	..	..	..	..	..	..	..		..	..	..	..	..	..	..	..
Mean wind speed.	..	..	..	..	14·0	13·5	10·0	..	..	6·3	..	..	15·0	22·2	14·5	13·0
Total ..	..	..	..	..	1	6	7	..	..	3	..	..	2	6	2	1

TABLE I—UPPER WINDS

Speed	OCTOBER, 1934 N.	NE.	E.	SE.	S.	SW.	W.	NW.	NOVEMBER, 1934 N.	NE.	E.	SE.	S.	SW.	W.	NW
	SURFACE 0–3 m.p.h. 0. Total cases, 25.								SURFACE 0–3 m.p.h. 0. Total cases, 23.							
m.p.h.																
4–15 ..	4	8	2	..	..	..	..	..	10	9	..	..	..	..	..	2
16–31 ..	8	3	..	..	..	..	..	..	1	1	..	..	..	..	..	..
32–47 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
48 and over..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	16·6	11·6	5·0	..	..	..	..	..	12·1	11·2	..	..	..	..	..	8·0
TOTAL ..	12	11	2	..	..	..	..	..	11	10	..	..	..	..	..	2
	1,500 feet 0–3 m.p.h. 0. Total cases, 25.								1,500 feet 0–3 m.p.h. 0. Total cases, 22.							
m.p.h.																
4–15 ..	2	1	3	1	..	..	..	..	3	4	3	..	..	..	..	2
16–31 ..	6	10	2	..	..	..	..	..	3	7	..	..	..	..	..	..
32–47 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
48 and over..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	21·5	21·2	13·0	12·0	..	..	..	..	16·7	18·4	10·0	..	..	..	..	15·0
TOTAL ..	8	11	5	1	..	..	..	..	6	11	3	..	..	..	..	2
	3,000 feet 0–3 m.p.h. 0. Total cases, 25.								3,000 feet 0–3 m.p.h. 0. Total cases, 23.							
m.p.h.																
4–15 ..	..	3	2	..	..	..	..	..	..	4	3	..	..	..	..	..
16–31 ..	5	5	6	2	..	..	..	..	4	10	..	..	..	..	..	1
32–47 ..	2	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..
48 and over..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	25·7	19·0	18·1	21·5	..	..	..	..	19·5	18·2	15·0	..	..	..	..	17·0
TOTAL ..	7	8	8	2	..	..	..	..	4	15	3	..	..	..	..	1
	6,000 feet 0–3 m.p.h. 1. Total cases, 23.								6,000 feet 0–3 m.p.h. 2. Total cases, 20.							
m.p.h.																
4–15 ..	2	5	3	..	..	1	3	2	2	6	2	2	..	2	..	1
16–31 ..	..	1	4	..	..	..	..	1	..	1	..	..	..	..	..	2
32–47 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
48 and over..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	10·5	10·7	16·0	..	..	5·0	13·0	13·7	6·5	11·9	5·5	6·0	..	9·0	..	16·3
TOTAL ..	2	6	7	..	..	1	3	3	2	7	2	2	..	2	..	3
	10,000 feet 0–3 m.p.h. 2. Total cases, 13.								10,000 feet 0–3 m.p.h. 0. Total cases, 12.							
m.p.h.																
4–15 ..	..	1	3	1	2	1	..	1	3	3	..	..	..	1	1	..
16–31 ..	..	..	..	..	1	1	..	..	..	..	1	..	1	1	..	1
32–47 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
48 and over..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	..	13·0	9·3	5·0	13·0	13·5	..	5·0	9·7	7·0	17·0	..	18·0	16·0	6·0	27·0
TOTAL ..	..	1	3	1	3	2	..	1	3	3	1	..	1	2	1	1

TABLE II—UPPER WINDS

Speed	DECEMBER, 1934 N.	NE.	E.	SE.	S.	SW.	W.	NW.	JANUARY, 1935 N.	NE.	E.	SE.	S.	SW.	W.	NW.
Surface 0–3 m.p.h.	17. Total cases, 25.								16. Total cases, 26.							
m.p.h.																
4–15 ..	5	3	..	..	..	..	..	..	9	..	..	..	..	..	..	..
16–31 ..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..
32–47 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
48 and over..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	6·4	7·3	..	..	..	..	..	..	9·7	..	..	..	..	..	..	..
Total ..	5	3	..	..	..	..	..	..	10	..	..	..	..	..	..	..
1,500 feet 0–3 m.p.h.	0. Total cases, 25.								1. Total cases, 26.							
m.p.h.																
4–15 ..	5	3	..	..	..	..	..	1	2	3	..	1	..	..	..	1
16–31 ..	8	8	..	..	..	..	..	..	4	11	1	2	..	..	..	..
32–47 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
48 and over..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	17·2	18·8	..	..	..	..	..	10·0	22·7	19·9	19·0	18·7	..	..	..	9·0
Total ..	13	11	..	..	..	..	..	1	6	14	1	3	..	..	..	1
3,000 feet 0–3 m.p.h.	0. Total cases, 25.								0. Total cases, 26.							
m.p.h.																
4–15 ..	3	2	..	..	..	..	..	..	3	2	1	1	..	..	..	1
16–31 ..	11	7	..	..	..	..	..	1	7	6	3	..	1	..	1	..
32–47 ..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
48 and over..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	19·1	19·0	..	..	..	..	..	19·0	19·3	18·0	17·7	13·0	23·0	..	21·0	5·0
Total ..	15	9	..	..	..	..	..	1	10	8	4	1	1	..	1	1
6,000 feet 0–3 m.p.h.	0. Total cases, 24.								1. Total cases, 26.							
m.p.h.																
4–15 ..	3	6	1	..	..	..	..	3	3	2	1	..	1	1	1	5
16–31 ..	4	1	1	..	1	..	..	4	1	..	2	..	1	3	..	2
32–47 ..	..	..	..	..	..	..	..	..	..	1	..	..	..	1	..	..
48 and over..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	16·9	11·3	11·0	..	17·0	..	..	16·7	10·3	17·0	20·3	..	17·0	21·8	9·0	11·1
Total ..	7	7	2	..	1	..	..	7	4	3	3	..	2	5	1	7
10,000 feet 0–3 m.p.h.	1. Total cases, 17.								0. Total cases, 22.							
m.p.h.																
4–15 ..	3	2	..	..	..	..	3	2	1	1	..	..	..	..	1	5
16–31 ..	..	..	..	1	..	..	3	2	1	1	1	..	1	..	4	1
32–47 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	4	1
48 and over..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	10·7	12·0	..	24·0	..	..	14·7	15·0	18·0	13·0	21·0	..	23·0	..	27·3	18·1
Total ..	3	2	..	1	..	..	6	4	2	2	1	..	1	..	9	7

TABLE III—UPPER WINDS

Speed	FEBRUARY, 1935 N.	NE.	E.	SE.	S.	SW.	W.	NW.	MARCH, 1935 N.	NE.	E.	SE.	S.	SW.	W.	NW.
	SURFACE 0–3 m.p.h. 16. Total cases, 24.								SURFACE 0–3 m.p.h. 16. Total cases, 24.							
m.p.h.																
4–15 ..	2	4	..	..	..	..	..	..	6	..	..	..	..	..	..	..
16–31 ..	2	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..
32–47 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
48 and over..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	16·0	5·0	..	..	..	..	..	..	13·5	..	..	..	..	..	..	..
TOTAL ..	4	4	..	..	..	..	..	..	8	..	..	..	..	..	..	..
	1,500 feet 0–3 m.p.h. 0. Total cases, 24.								1,500 feet 0–3 m.p.h. 1. Total cases, 24.							
m.p.h.																
4–15 ..	..	3	2	1	..	..	..	..	1	..	..	2	..	..	..	..
16–31 ..	7	8	1	1	..	..	..	..	8	11	1	..	..	..	..	..
32–47 ..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
48 and over..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	26·0	19·3	15·0	19·5	..	..	..	..	22·1	20·8	17·0	11·0	..	..	..	..
TOTAL ..	8	11	3	2	..	..	..	..	9	11	1	2	..	..	..	..
	3,000 feet 0–3 m.p.h. 0. Total cases, 24.								3,000 feet 0–3 m.p.h. 0. Total cases, 23.							
m.p.h.																
4–15 ..	2	2	..	1	..	..	..	..	..	2	..	2	..	..	..	..
16–31 ..	8	5	1	2	..	..	..	..	6	10	2	..	..	..	..	..
32–47 ..	3	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..
48 and over..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	23·9	18·6	31·0	17·7	..	..	..	..	24·6	21·5	23·5	13·0	..	..	..	..
TOTAL ..	13	7	1	3	..	..	..	..	7	12	2	2	..	..	..	..
	6,000 feet 0–3 m.p.h. 0. Total cases, 23.								6,000 feet 0–3 m.p.h. 0. Total cases, 21.							
m.p.h.																
4–15 ..	2	4	..	..	..	..	3	3	..	6	..	1	..	..	2	1
16–31 ..	5	..	1	2	..	..	1	1	2	6	2	..	..	..	..	..
32–47 ..	1	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..
48 and over..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	22·1	13·0	17·0	19·0	..	..	10·5	15·3	25·3	16·7	20·5	9·0	..	..	8·0	15·0
TOTAL ..	8	4	1	2	..	..	4	4	3	12	2	1	..	..	2	1
	10,000 feet 0–3 m.p.h. 0. Total cases, 17.								10,000 feet 0–3 m.p.h. 0. Total cases, 17.							
m.p.h.																
4–15 ..	1	..	..	1	1	..	1	3	3	1	..	..	..	..	..	2
16–31 ..	1	1	1	..	..	..	2	5	3	3	..	..	..	..	2	..
32–47 ..	..	..	..	..	..	..	..	..	2	..	..	..	..	..	1	..
48 and over..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	16·0	29·0	18·0	13·0	13·0	..	21·7	17·6	22·9	21·5	..	..	..	..	26·7	11·0
TOTAL ..	2	1	1	1	1	..	3	8	8	4	..	..	..	..	3	2

TABLE IV—UPPER WINDS

Speed	APRIL, 1935 N.	NE.	E.	SE.	S.	SW.	W.	NW.	MAY, 1935 N.	NE.	E.	SE.	S.	SW.	W.	NW.
	SURFACE 0–3 m.p.h. 12. Total cases, 25.								SURFACE 0–3 m.p.h. 10. Total cases, 23.							
m.p.h.																
4–15 ..	6	4	..	..	1	..	..	1	5	1	1	1	1	..	..	1
16–31 ..	1	..	..	..	..	..	..	..	1	..	..	1	..	..	..	1
32–47 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
48 and over..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	6·5	4·0	..	..	7·0	..	..	4·0	8·1	5·0	9·0	14·0	9·0	..	..	12·0
TOTAL ..	7	4	..	..	1	..	..	1	6	1	1	2	1	..	..	2
	1,500 feet 0–3 m.p.h. 0. Total cases, 25.								1,500 feet 0–3 m.p.h. 1. Total cases, 23.							
m.p.h.																
4–15 ..	..	3	2	2	..	..	..	..	1	4	1	2	1	..	..	..
16–31 ..	8	7	3	..	..	..	..	..	2	8	..	2	1	..	..	..
32–47 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
48 and over..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	22·1	19·1	19·8	11·0	..	..	..	..	16·7	16·7	14·0	17·5	17·0	..	..	..
TOTAL ...	8	10	5	2	..	..	..	..	3	12	1	4	2	..	..	..
	3,000 feet 0–3 m.p.h. 0. Total cases, 24.								3,000 feet 0–3 m.p.h. 0. Total cases, 23.							
m.p.h.																
4–15 ..	2	..	..	..	..	..	..	..	..	3	2	..	..	..	..	1
16–31 ..	9	4	1	3	..	..	..	..	1	9	1	3	2	..	..	..
32–47 ..	1	2	2	..	..	..	..	..	..	1	..	..	..	..	..	..
48 and over..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	21·5	27·3	37·7	28·3	..	..	..	..	18·0	19·4	19·0	24·0	22·5	..	..	5·0
TOTAL ..	12	6	3	3	..	..	..	..	1	13	3	3	2	..	..	1
	6,000 feet 0–3 m.p.h. 0. Total cases, 23.								6,000 feet 0–3 m.p.h. 0. Total cases, 22.							
m.p.h.																
4–15 ..	3	..	1	..	..	1	..	..	3	4	3	..	1	..	..	1
16–31 ..	6	4	3	1	..	..	..	1	1	3	5	..	..	..	..	..
32–47 ..	..	1	..	..	..	..	1	..	..	..	..	1	..	..	..	..
48 and over..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	19·3	24·8	27·6	31·0	..	5·0	39·0	18·0	13·3	15·7	16·1	43·0	7·0	..	..	13·0
TOTAL ..	9	5	5	1	..	1	1	1	4	7	8	1	1	..	..	1
	10,000 feet 0–3 m.p.h. 0. Total cases, 14.								10,000 feet 0–3 m.p.h. 1. Total cases, 13.							
m.p.h.																
4–15 ..	1	..	1	..	..	..	..	..	1	4	1	..	1	1	..	..
16–31 ..	3	3	1	..	..	..	1	3	1	..	..	..	..	..	..	3
32–47 ..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..
48 and over..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	19·3	22·0	12·0	..	..	..	37·5	19·0	17·5	10·3	12·0	..	11·0	5·0	..	20·7
TOTAL ..	4	3	2	..	..	..	2	3	2	4	1	..	1	1	..	3

TABLE V—UPPER WINDS

Speed.	JUNE, 1935 N.	NE.	E.	SE.	S.	SW.	W.	NW.	JULY, 1935 N.	NE.	E.	SE.	S.	SW.	W.	NW.
	SURFACE 0–3 m.p.h. 16. Total cases, 25.								SURFACE 0–3 m.p.h. 22. Total cases, 28.							
m.p.h.																
4–15 ..	7	1	..	..	..	..	..	..	5	..	..	..	..	..	..	1
16–31 ..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
32–47 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
48 and over..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	8·1	7·0	..	..	..	..	..	..	5·4	..	..	..	..	..	..	5·0
TOTAL ..	8	1	..	..	..	..	..	..	5	..	..	..	..	..	..	1
	1,500 feet 0–3 m.p.h. 0. Total cases, 25.								1,500 feet 0–3 m.p.h. 1. Total cases, 28.							
m.p.h.																
4–15 ..	4	4	1	..	..	..	..	1	10	2	..	..	..	..	..	..
16–31 ..	9	6	..	..	..	..	..	..	8	7	..	..	..	..	..	..
32–47 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
48 and over..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	17·7	17·7	15·0	..	..	..	..	9·0	15·7	16·9	..	..	..	..	..	..
TOTAL ..	13	10	1	..	..	..	..	1	18	9	..	..	..	..	..	..
	3,000 feet 0–3 m.p.h. 1. Total cases, 25.								3,000 feet 0–3 m.p.h. 1. Total cases, 28.							
m.p.h.																
4–15 ..	4	4	..	..	..	..	1	1	3	2	..	..	..	..	..	2
16–31 ..	9	4	..	..	..	..	..	..	18	1	..	..	..	..	..	..
32–47 ..	1	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..
48 and over..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	21·1	17·7	..	..	..	..	15·0	11·0	21·6	12·3	..	..	..	..	..	9·0
TOTAL ..	14	8	..	..	..	..	1	1	22	3	..	..	..	..	..	2
	6,000 feet 0–3 m.p.h. 0. Total cases, 23.								6 000 feet 0–3 m.p.h. 0. Total cases, 26.							
m.p.h.																
4–15 ..	4	..	3	1	..	..	..	2	3	..	..	..	..	..	2	9
16–31 ..	7	1	..	..	..	..	..	5	2	..	..	..	..	..	..	9
32–47 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
48 and over..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	18·2	22·0	11·0	6·0	..	..	..	16·7	15·8	..	..	..	..	..	15·0	17·8
TOTAL ..	11	1	3	1	..	..	..	7	5	..	..	..	..	..	2	19
	10,000 feet 0–3 m.p.h. 1. Total cases, 17.								10,000 feet 0–3 m.p.h. 2. Total cases, 11.							
m.p.h.																
4–15 ..	1	..	3	1	1	1	2	2	..	..	..	..	..	2	1	..
16–31 ..	1	1	..	..	..	..	..	3	..	..	..	..	..	..	5	1
32–47 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
48 and over..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean wind speed.	10·5	21·0	14·0	11·0	9·0	11·0	14·0	19·2	..	..	..	..	..	13·0	19·8	31·0
TOTAL ..	2	1	3	1	1	1	2	5	..	..	..	..	..	2	6	1

TABLE VI—UPPER WINDS

S.O. Code 40–57–72

(31383) Wt. 3730/2831 625 8/36 Hw. G.371

Plate I

FIG.1, AUGUST 1934

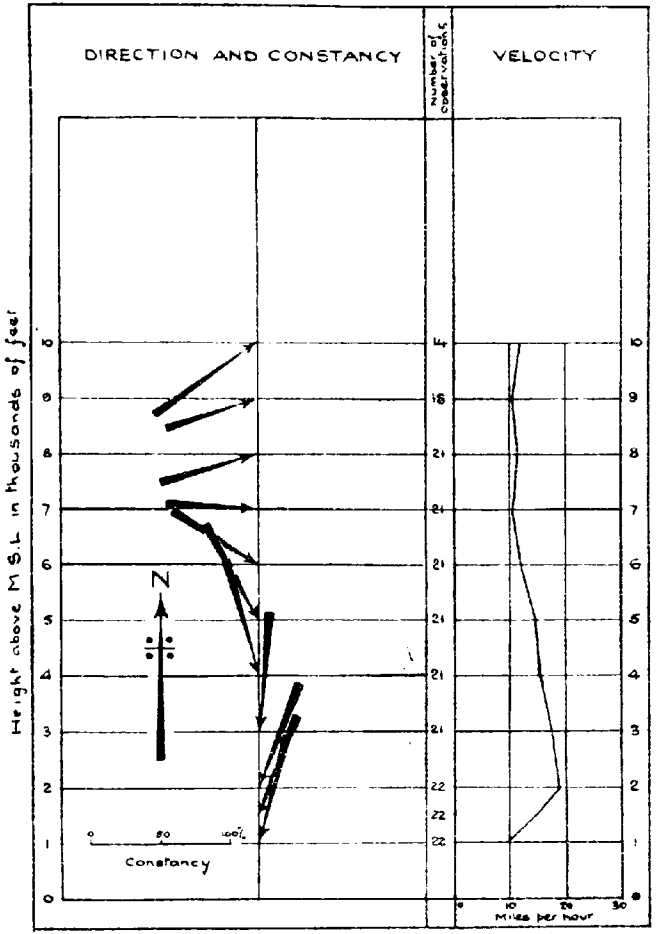
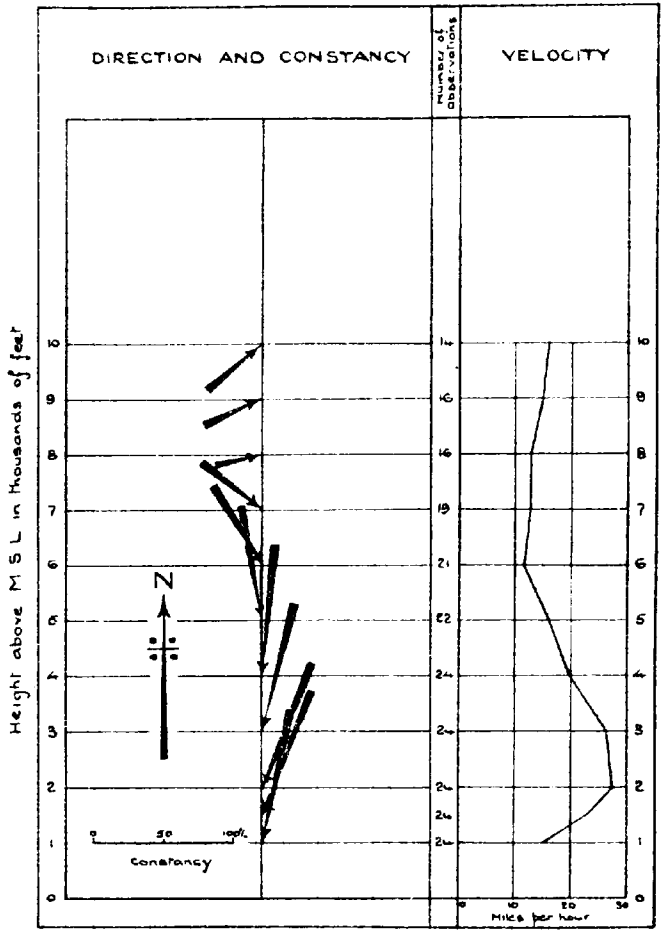


FIG.2, SEPTEMBER 1934



The constancy of the wind is indicated by the length of the direction arrow

(2310)3730A,625,7'36 Gp 9281 & R LTD

FIG.3, OCTOBER 1934

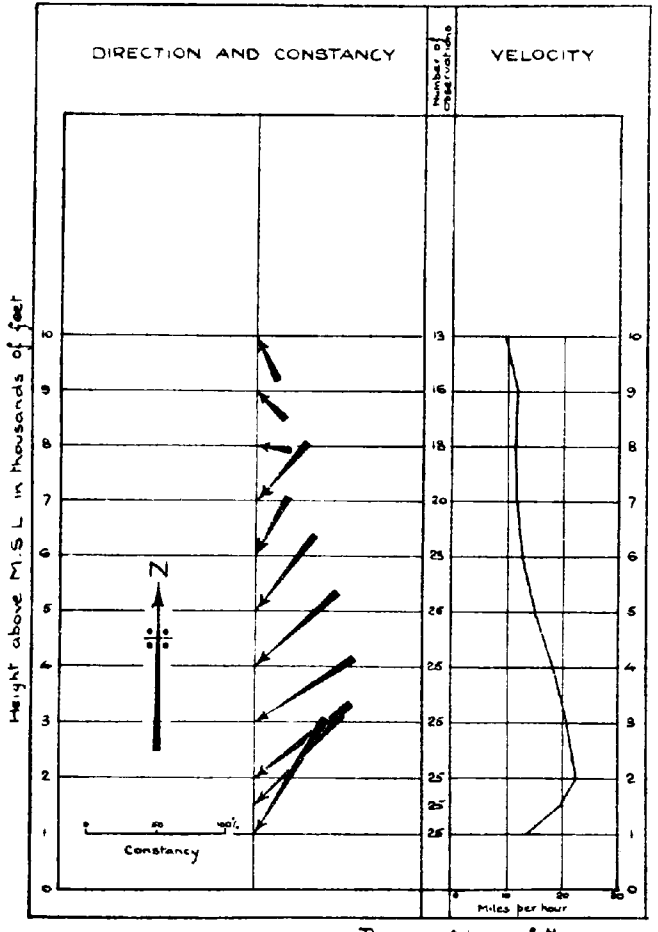


FIG.4, NOVEMBER 1934

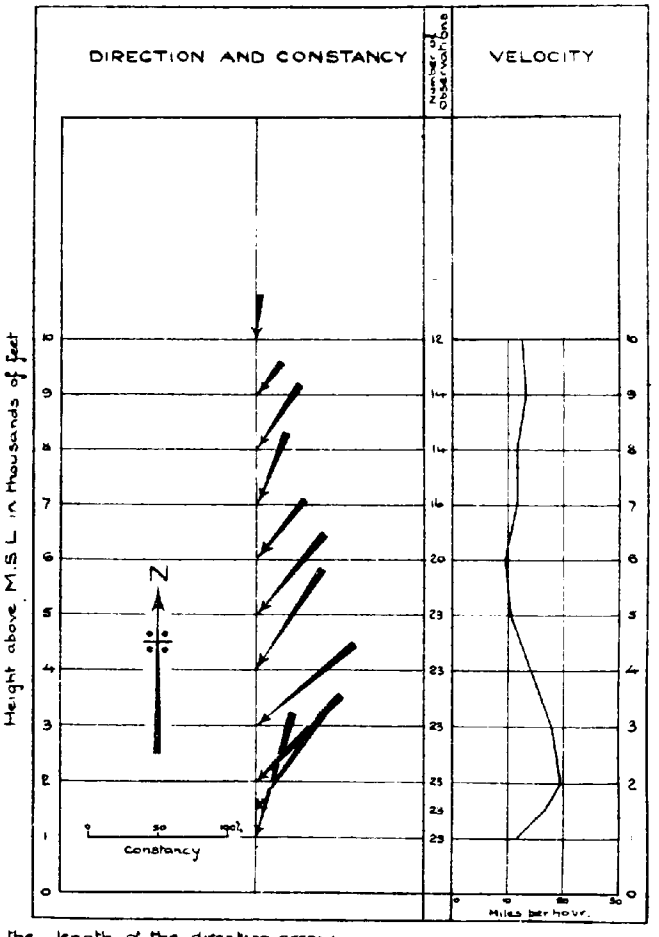


Plate II

The constancy of the wind is indicated by the length of the direction arrow.

FIG.5, DECEMBER 1934

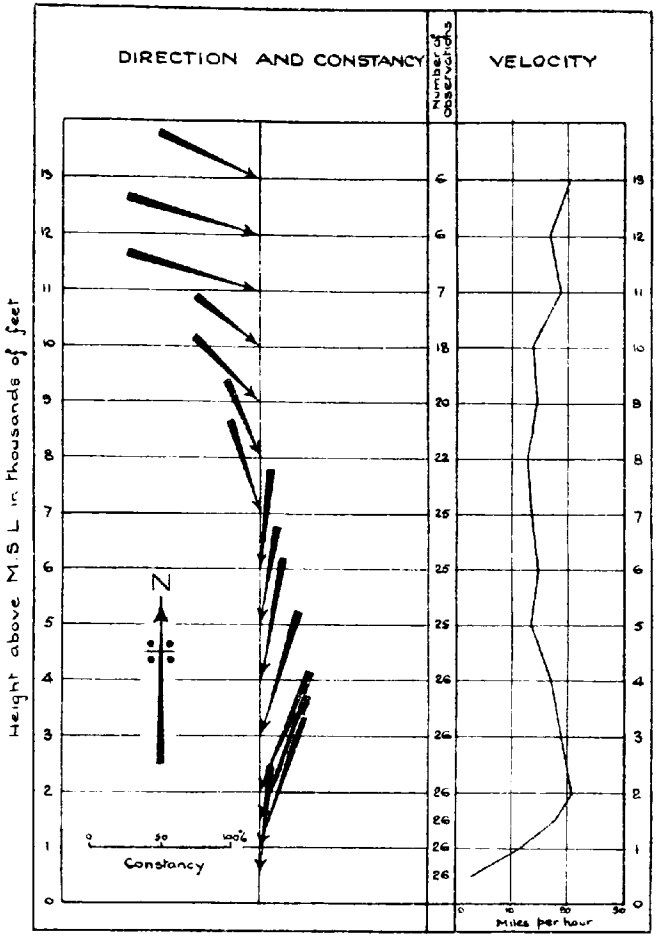
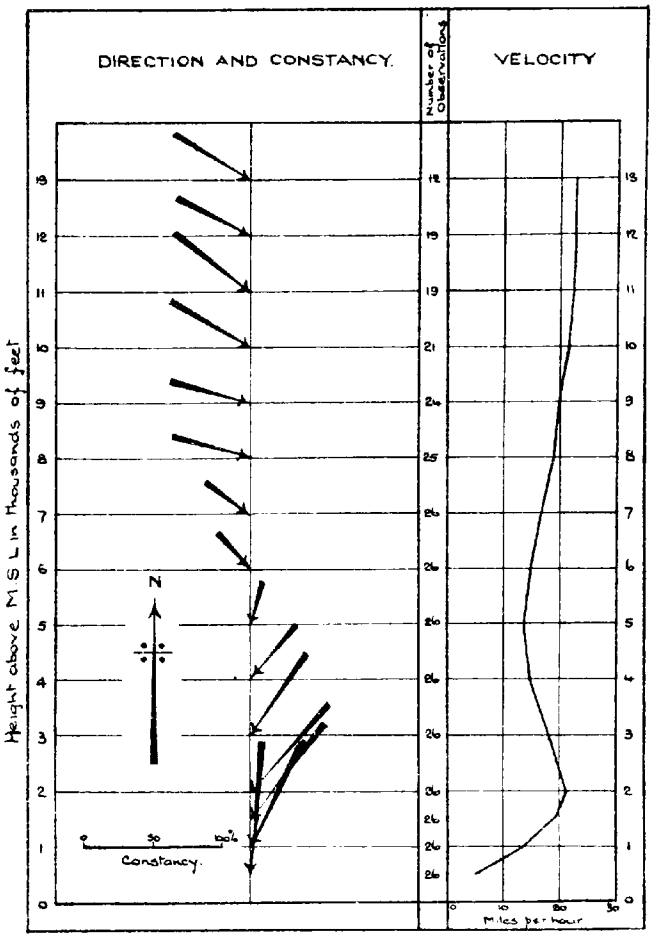


FIG.6, JANUARY 1935



The constancy of the wind is indicated by the length of the direction arrow

Plate III

FIG. 7, FEBRUARY 1935

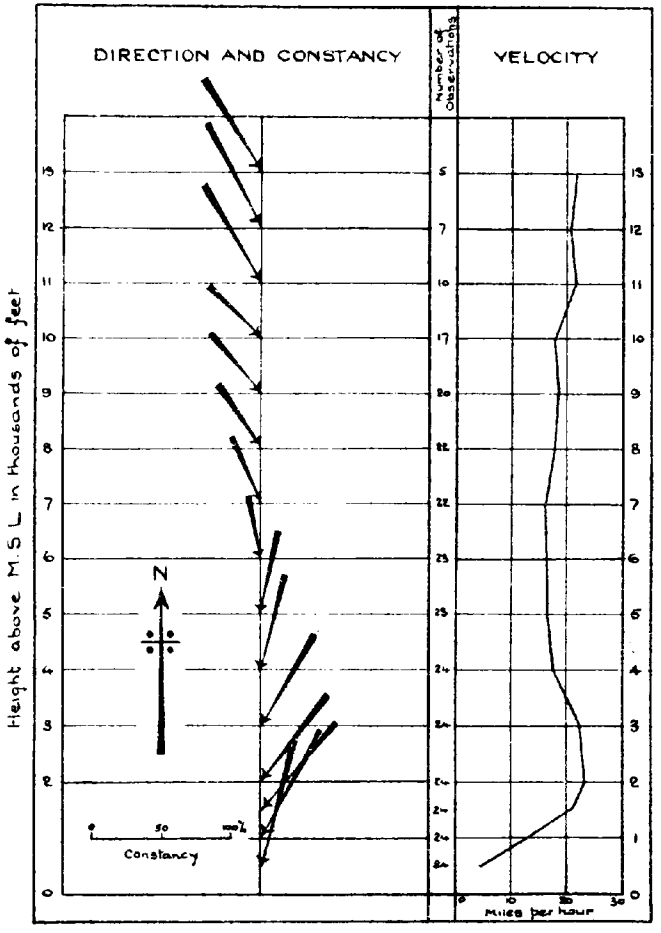
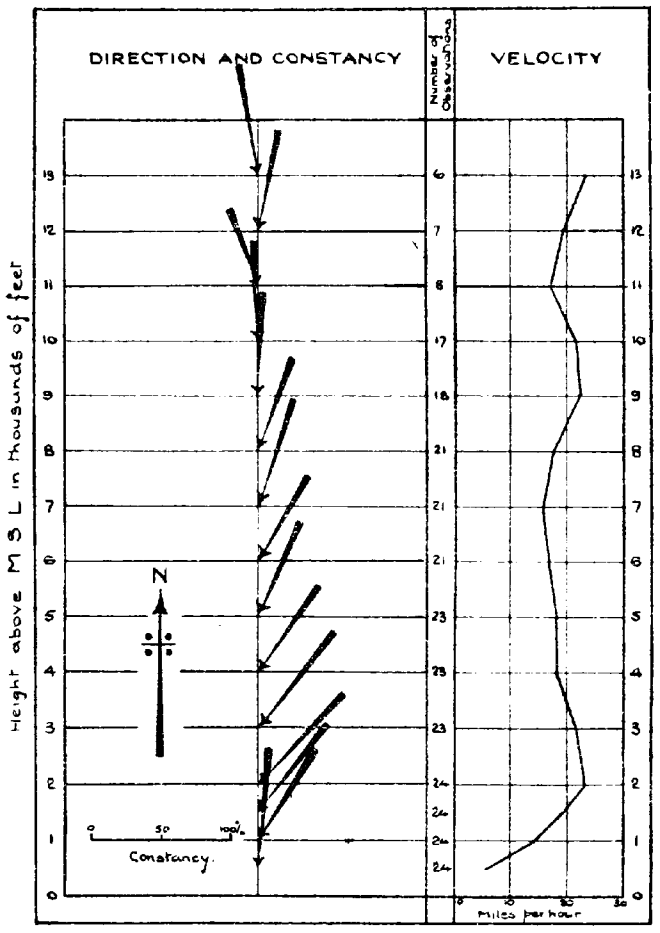


FIG. 8, MARCH 1935



The constancy of the wind is indicated by the length of the direction arrow

Plate IV

FIG.9, APRIL 1935

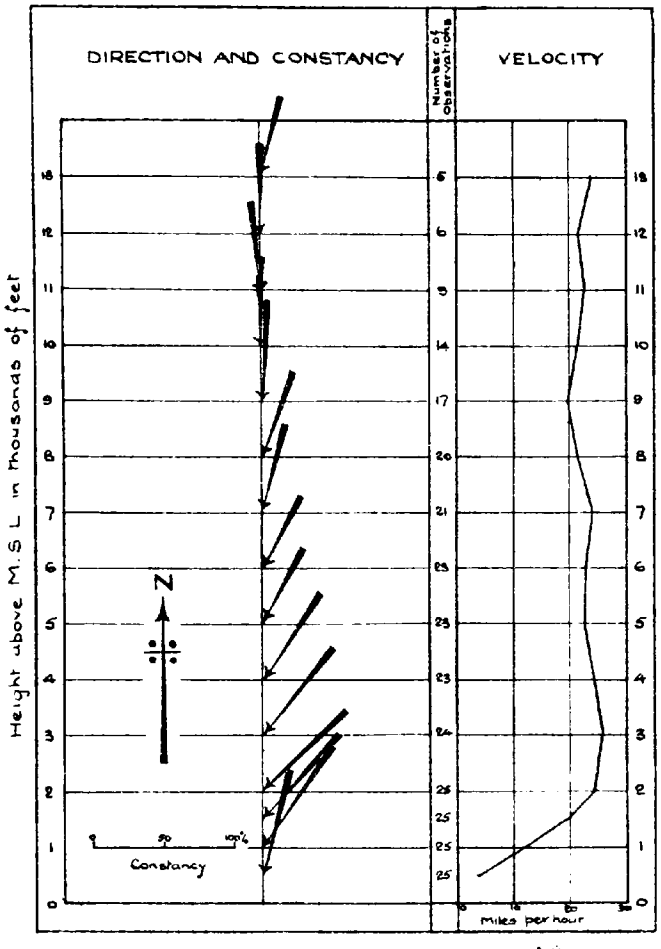


FIG.10, MAY 1935

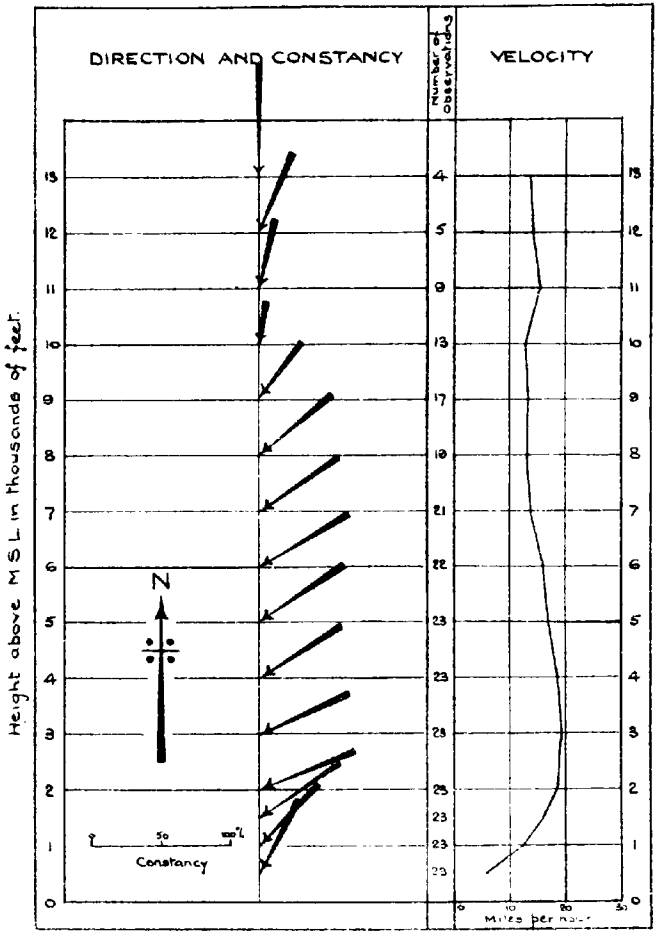


Plate V

The constancy of the wind is indicated by the length of the direction arrow

FIG. 11, JUNE 1935

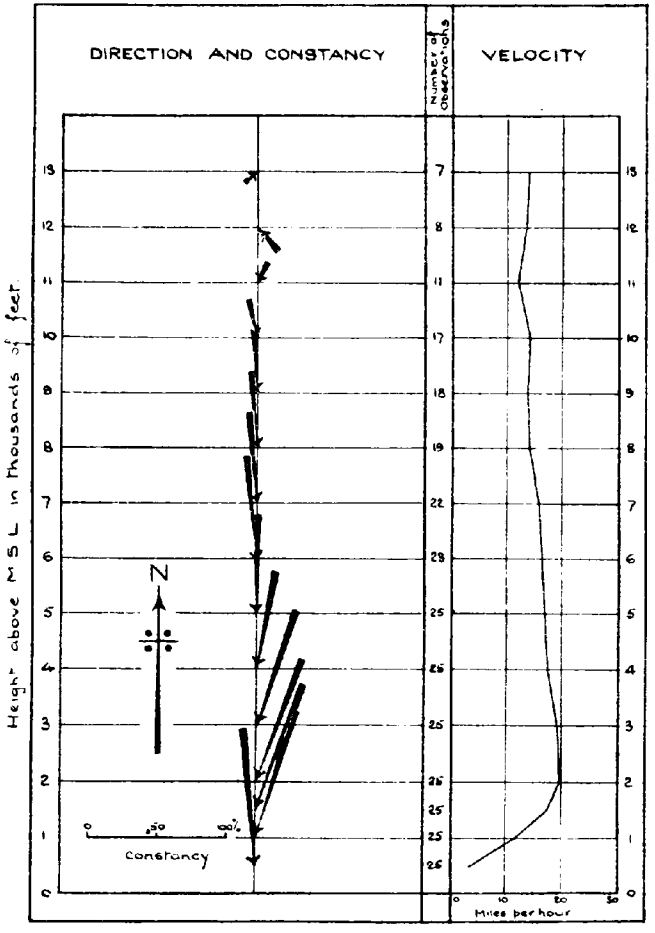


FIG. 12, JULY 1935

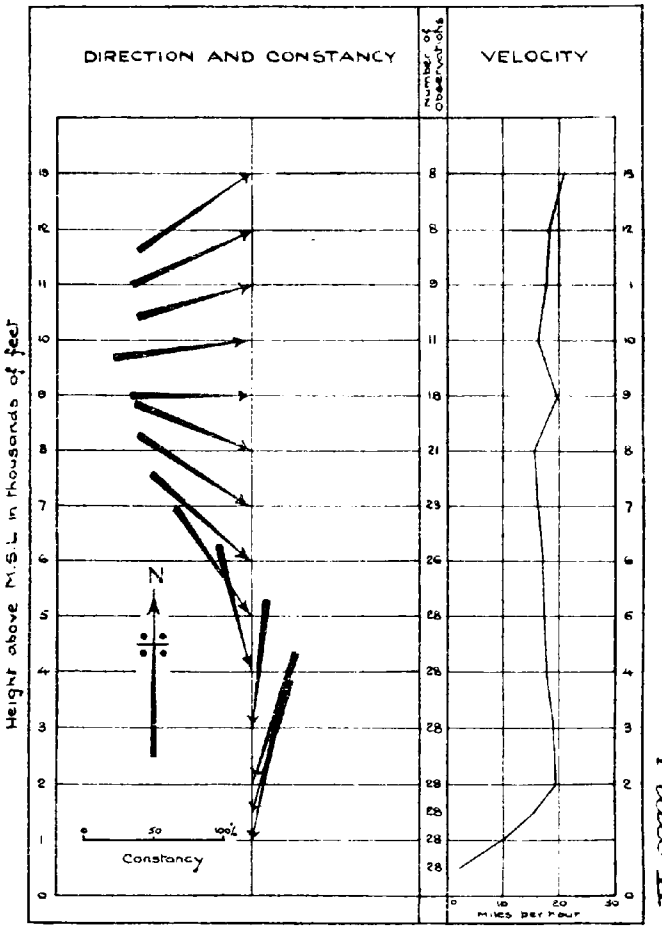


Plate VI

The constancy of the wind is indicated by the length of the direction arrow